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Power Evaluation System/Model 7100 Installation Guide

BMI
The Power of Quality

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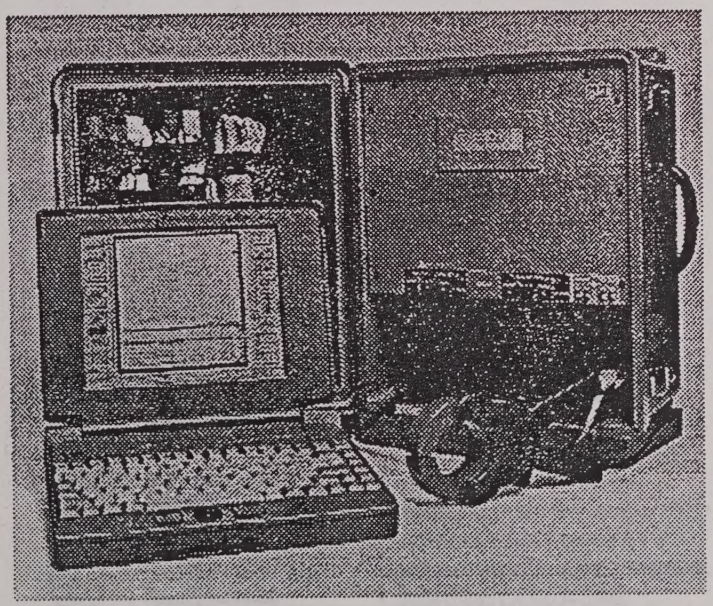

Power Evaluation System/Model 7100 Installation Guide

Warning! *The installation instructions in this guide are for use by qualified personnel only. Do not install this instrument on a power line unless you are qualified to do so. High voltages that cause burns and lethal shocks are present during power monitoring. When making connections to power lines, always connect the safety earth ground first.*

This symbol indicates maximum input voltage to instrument not to exceed 600 Vrms.

Protective ground (earth) terminal.

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Warranty

BMI warrants that the PES/Model 7100 will be free from defects in workmanship and materials for a period of one year from the date of purchase. BMI will, without charge, replace or repair, at its option, any warranted product returned to the BMI factory service department.

BMI shall not be held liable for any consequential damages, including without limitation, damages resulting from loss of use, or damages resulting from the use or misuse of this product. Some states do not allow limitations of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may also have rights which vary from state to state.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized repairs or alterations.

FCC Statement

The PES/Model 7100 has been type-tested and complies with the limits for a Class B computing device pursuant to Subpart J of Part 15 of the FCC regulations. These rules are intended to provide reasonable protection against radio-frequency interference from computing devices in a residential installation. However, no guarantee exists that interference will not occur in a specific installation.

If nearby radio-frequency devices (such as radios and televisions) show the effects of interference when the PES/Model 7100 is turned on, and it stops when the Model/7100 is turned off, the Model 7100 is causing interference. One or more of the following measures should correct the interference:

- Reorient the antenna of the receiving device
- Reorient the PES/Model 7100 with respect to the antenna
- Move the PES/Model 7100 and the receiving device further apart
- Plug the receiving device and the PES/Model 7100 into different AC power circuits

If these measures do not resolve the problem, consult your dealer or an experienced radio/television technician. You may call BMI Customer Service, but interference problems can rarely be resolved by a telephone conversation.

Changes or modifications not expressly approved by BMI could void the user's authority to operate the equipment.

Table of Contents

1 Product Overview 1
Hardware Description 2
2 Impatient User's Guide 7
3 Getting Started 13
Mounting the Enclosure 13
Portable Use 13
Making Connections 14
Reading the LCD Display 17
4 Connecting to a PC 19
Making the Local RS-232 Connection 19
Using the Internal Modem 19
Using the BMI Power Evaluation Software 20
5 Need Help? 21
Things to Look for 21
The BMI Power Evaluation Software *HELP* Function 22
6 Specifications 23
7 Glossary 27

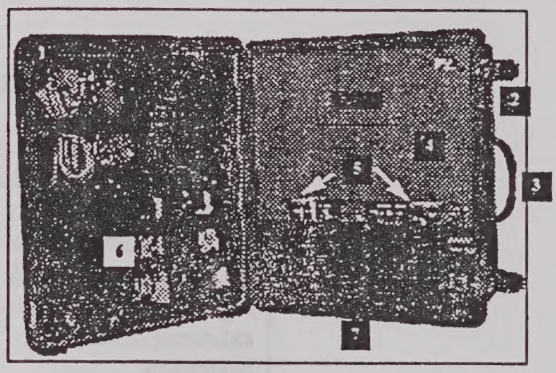
1 Product Overview

PES/Model 7100 Overview

Congratulations on your purchase of the PES/Model 7100, a sophisticated monitoring instrument with a powerful combination of Power Quality features. Every cycle of single-phase or three-phase voltage and current is monitored continuously.

The PES/Model 7100 provides high speed capture of RMS sag and swell disturbances, waveshape faults, impulses, and harmonics data. Summary data, with a storage interval defined by the user, includes historical arrays of each voltage and current input.

Product Overview 1



Hardware Description

1 **NEMA 4X Enclosure** - Each PES/Model 7100 is housed in a sturdy, lightweight, weatherproof enclosure intended for indoor or outdoor use. The corrosion-resistant enclosure will withstand windblown dust and rain, splashing water, hose-directed water, and ice formation.

2 **Lockable Hasps** - Two hasps are located on the right side of the enclosure, allowing the installation of a user-supplied padlock.

3 **Carrying Handle** - For portable use, the handle makes it easy to carry the PES/Model 7100 from site to site.

1 Product Overview

4 **Battery** - The PES/Model 7100 includes a built-in rechargeable battery system, which allows the Model 7100 to store critical data for up to 14 days without the presence of AC power. All set-up data, program information, and calibration data is stored in non-volatile FLASH memory, which is stored indefinitely regardless of the battery status.

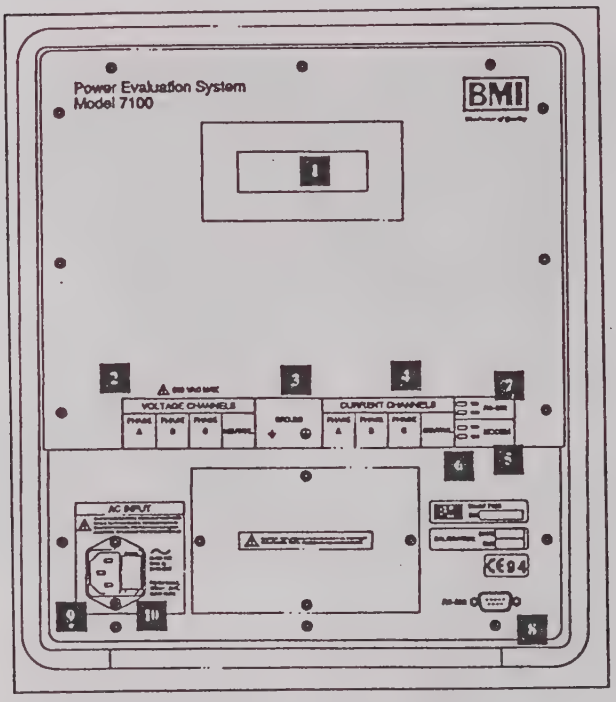
5 **Voltage and Current Inputs** - Field terminations are made using plug-in connectors. BMIís unique ID Probe technology allows straightforward installation of clamp-on CTs to any common power type.

6 **Cable Pallet** - An array of voltage and power connection cables and adapters is included with each PES/Model 7100. This pallet may be left inside the door of the enclosure, or removed and stored separately.

7 **Cable Guide** - This BMI innovation (patent pending) keeps the voltage and current probe cables out of the way during enclosure interior access, and ensures a tight seal across the lip of the enclosure.

Product Overview

1



PES/Model 7100 front panel display

1 Product Overview

Front Panel Inputs

1 **LCD Display** - A reflective liquid-crystal display provides visual feedback from the PES/ Model 7100. Information such as voltage and current values, time, date, site name, configuration set-up, memory full status, battery status, and hardware/firmware versions are available at a glance.

2 **Voltage Connectors** - Accepts 10-600 Vrms phase A, B, C, and neutral (if applicable). Standard voltage cables with safety connectors are included. For increased safety, we recommend the optional BMI FuseClip voltage connector cables.

WARNING! *Do not use connecting cords with ordinary banana plugs.*

3 **Ground Connectors** - Two ground connectors are included, providing separate connections for measurement ground and safety ground. The measurement ground connector uses the same cable type as the other voltage connectors, while the safety ground connector uses a two-way binding post.

4 **Current Probe Connectors** - Four current probe latching mini-DIN connectors are provided for phase A, B, and C, plus the neutral conductor. These inputs connect to the BMI ID Current Probes.

Important Note: The PES/Model 7100 is designed to measure current with BMI ID Current Probes. Other CTs are not compatible with the Model 7100

Product Overview 1

5 **Modem LEDs** - Light-emitting diodes allow visual monitoring of communication transmit and receive status. When the optional internal PES/Model 7100 modem is installed, the LED's will blink during remote communications activity.

6 **Modem Phone Jack** - An RJ-11 phone jack is provided for connection to the switched telephone network, for those Model 7100s equipped with the internal modem option.

7 **RS-232 LEDs** - When local communications are in progress, light-emitting diodes blink to indicate the transmit and receive status.

8 **RS-232 Connector** - A 9-pin D-type female connector is used for communicating directly to a PC via RS-232. The cable requires a 9-pin D-type male connector for the Model 7100 on one end and a connector to match the PC on the other end.

9 **Power Cord Connector** - For connections to AC power, 80 to 250 Vrms, 50 or 60 Hz.

10 **Fuse Compartment** - The PES/Model 7100 includes two 500 mA slow blow fuses, for line and neutral, which measure 5 x 20 mm each.

2 Impatient User's Guide

To begin using your PES Model 7100...

Step One: Unpack your PES/ Model 7100

Make sure the instrument and all of its accessories have been received in good order. Check for any damage which may have occurred in shipment. Be sure the following items have been included:

- PES/Model 7100 and Installation Guide
- Registration and Warranty Cards
- Cable Pallet

The following items are optional and should have been included if ordered:

- FuseClip(Voltage Probes (4)
- BMI ID Current Probes (4 required for full three-phase measurements)
- BMI Power Evaluation Software · with RS-232 Cable

If you are missing any of the above items, please contact BMI sales at (408) 970-3700.

Impatient User's Guide 2

Set up the PES/Model 7100 for Three-Phase Quality Monitoring

In order to connect the PES/Model 7100 for three-phase wye monitoring, you will need the instrument, cable pallet with voltage probes, and four BMI ID Current Probes. (Delta measurements require three BMI ID Current Probes).

> WARNING! *You are working with high voltages that cause lethal burns and shocks. Use standard safety precautions.*

Place the PES/Model 7100 on a flat non-conductive surface near the point to be monitored. If the Model 7100 is to be wall-mounted, we recommend that you first read Section 3 of this Installation Guide.

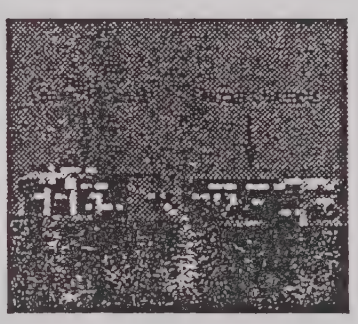


Figure 3: Model 7100 Voltage and current connection panel.

1. If the per-phase measured voltage is between 80 and 250 V_{rms} the PES/Model 7100 may be powered directly from a phase using the BMI power adapter cable, included in the Model 7100 Cable Pallet. Otherwise, the Model 7100 must be powered from an external source using the included power cord. If using the power adapter, insert the 3-prong male connector into the PES/Model 7100 power cord connector. Attach the three

2 Impatient User's Guide

double-sided safety voltage connectors into the corresponding voltage connectors on the input panel. The red connector goes to phase A, the black connector goes to neutral and the green/yellow connector goes to ground. The power adapter safety voltage connectors will still allow the connection of the incoming measured voltage.

2. Connect the Earth and Safety grounds to their respective terminals as shown in Figure 3. Connect the voltage cables to the phase A, B, C and neutral connectors. Make sure that the cable colors correspond to the proper connector colors on the instrument. Care should be taken to properly orient the three phases. The color code is as follows:

   Phase A: Red
   Phase B: Yellow
   Phase C: Blue
   Neutral: White
   Ground: Green

3. Connect the BMI ID Current Probes to the current channel input connectors, as shown in Figure 3.

4. Clamp the current probes around the conductors to be measured. Be sure to align the current probes with the correct phases. Observe the direction of current flow on the probes.

   Clip the voltage probes to the terminals to be measured. Connect the ground wire first, then the voltage phases and neutral.

Impatient User's Guide 2

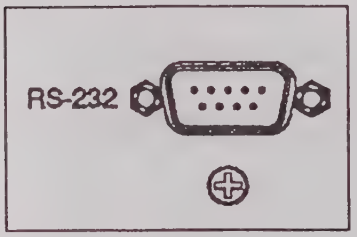


Figure 4: RS-232 Port

5. The PES/Model 7100 will now begin displaying data. To initialize the Model 7100, either connect the RJ-11 phone jack to a dial-up phone line, or connect the RS-232 connector to a local PC with the Power Evaluation Software RS-232 cable, as shown in figure 4. Then, using the BMI Power Evaluation Software, execute the Set-up portion of the software and place the Model 7100 in Power Quality mode. Please refer to the BMI Power Evaluation Software User's Guide for details on the instrument set-up procedure. Be sure to properly set the power system type, either delta, wye, single-phase, or split single-phase. Check the PES/Model 7100 LCD display readings of voltage and current to be sure proper connections have been made.

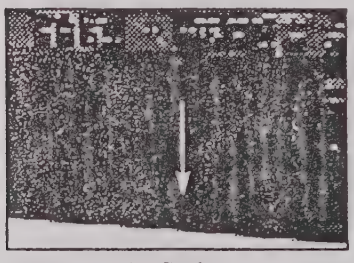


Figure 5: Cable Guide

6. The PES /Model 7100 has now been completely configured for monitoring. The set-up parameters defined in the Power Evaluation Software will determine the

2 Impatient User's Guide

maximum duration of the monitoring period. Arrange the voltage, current, and communication cables such that they feed through the slots in the cable guide (please refer to figure 5), and close the enclosure door. Snap closed the hasps at the top and bottom right side. Lock the hasps with a padlock or other means if desired.

7. If you need help along the way, please consult the remainder of the Installation Guide for more complete information and descriptions of the installation procedures. Help may also be obtained from the BMI Power Evaluation Software User's Guide, and through the built-in on-line help facility in the Power Evaluation Software.

3 Getting Started

Mounting the Enclosure

Enclosure

The standard NEMA 4X enclosure is made of non-conductive fiberglass, and provides protection from corrosion, windblown dust and rain, splashing water, hose-directed water, and ice formation. It may be used indoors or outdoors. Contact BMI for other environmental concerns.

Mounting Holes

The mounting holes on the top and bottom flanges of the enclosure are 1/2 in diameter. See Figure 6 for additional dimensions.

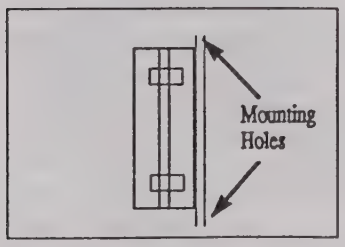


Figure 6: Model 7100 side view

Portable Use

The PES/Model 7100, with its integral carrying handle, is designed to also be used on a portable basis, without requiring the physical installation of the enclosure. When used in this fashion, the Model 7100 may be placed on any solid, secure, non-conducting surface. The PES/Model 7100 should only be used for temporary monitoring without installation. For extended monitoring periods, the PES/Model 7100 should be permanently affixed to a wall, pole, or other permanent structure.

Getting Started

3

Making Connections

Instrument Power Connections

The PES/Model 7100 may be powered either from one of the measured phases, or from an external AC power source. To use a phase for instrument power, the voltage must be between 80 and 250 V_{rms}, with a 50 or 60 Hz fundamental line frequency.

Connection between the power cord connector and the instrument is made using the power adapter included in the cable pallet. The power adapter allows connection to any monitored phase. To use the power adapter, insert the 3-prong male power adapter connector into the PES/Model 7100 power cord connector. Figures 7 through 10 show the power input connections which may be made based on the power system type. Attach the three double-sided safety voltage connectors into the corresponding voltage connectors on the input panel. The red connector goes to phase A, the black connector to neutral and the green/yellow connector goes to ground. The opposite ends of the power adapter safety voltage connectors will attach to the voltage probe cables.

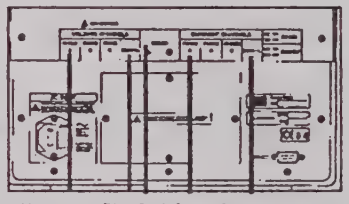


Figure 7: Single-Phase Instrument Power Connection

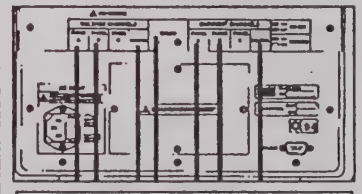


Figure 8: Split Single-Phase Instrument Power Connection

3 Getting Started

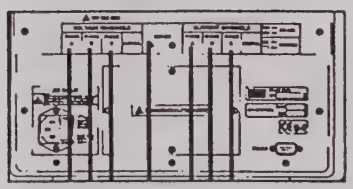


Figure 9: 3-phase, 3-wire Delta instrument power connection

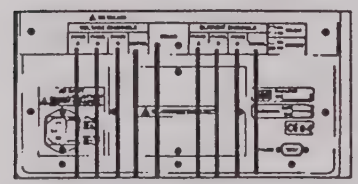


Figure 10: 3-Phase, 4-wire Wye instrument power connection

If the measured voltage is not within 80 and 250 V_{rms}, the standard power cord must be used. A power cord compatible with the anticipated destination country is included with each PES/Model 7100. The standard power cord may also be used in cases where the user would like the instrument power to be isolated from the monitored power. To use the standard power cord, attach it to the PES/Model 7100 power cord connector and feed the cable through the cable guide at the bottom of the Model 7100 enclosure. Plug the end of the power cord into an appropriate power source, between 80 and 250 V_{rms}. Be sure the line frequency is 50 or 60 Hz, ±0.1 Hz.

WARNING! *Make sure safety ground is connected first before measuring power.*

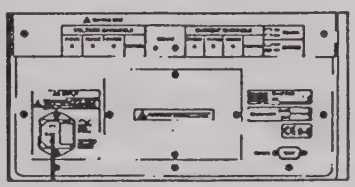


Figure 11: Power cord connection

Getting Started

3

Measured Power Connections
Connect ground first, then connect the voltage probe cables to the phase A, B, C and neutral connectors. Use the diagrams in figures 12-15 as a guide. Match the cable colors to the proper voltage connector colors on the instrument. Care should be taken to properly orient the three phases.

Attach the current probes to the current channel input connectors, as shown in figures 12-15. Clamp the current probes around the conductors to be measured. Align the current probes with the correct phases. Verify the direction of current flow on the probes.

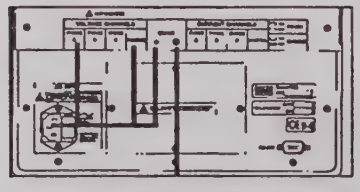


Figure 12: Single-phase voltage and current power connection

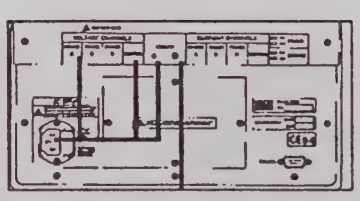


Figure 13: Split single-phase voltage and current power connection

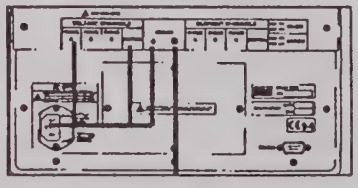


Figure 14: 3-phase, 3-wire Delta voltage and current power connection

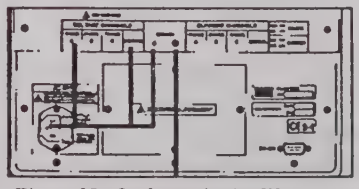


Figure 15: 3-phase, 4-wire Wye voltage and current power connection

3 Getting Started

Reading the LCD Display

The PES/Model 7100 includes a 4 line by 20 character LCD display, mounted on the front panel. The LCD display automatically displays critical operational information to the user, so that a quick, cursory check may be made locally. The LCD display is not intended to act as a user interface. Its purpose is to display instrument status.

There are three different displays which rotate through: The "voltage/current" screen number 1, the "site" screen number 2, and the "configuration" screen number 3. The voltage/current screen number 1 displays all measured currents and voltages, labeled as phase A, B, C, and neutral, as shown in figure 16. If the PES/Model 7100 is not attached to a 3-phase, four wire system, it will display zero values for the unused inputs.

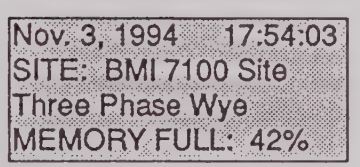


Figure 16: Voltage/current screen number LCD display

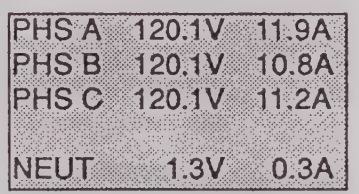


Figure 17: Site Screen number 2 LCD Display

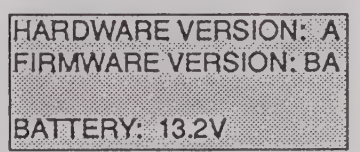


Figure 18: Site Screen number 3 LCD Display

Getting Started

3

The site screen number 2 displays site-specific data, including site name, power system type, time/date, and memory status. The site screen is shown in Figure 17.

The configuration screen number 3, as seen in Figure 18, displays hardware and firmware version numbers, as well as battery voltage. The configuration information is useful when consulting with BMI Technical Support Representative.

4 Connecting to a PC

Making the RS-232 Connection

The PES/Model 7100 communicates through its internal modem (optional), directly through its RS-232 port to a local PC, or through a user-supplied external modem through its RS-232 port. RS-232 Communications connections are made according to the diagram in Figure 19. For direct RS-232 communications be sure to use a Null Modem adapter, or a Null Modem cable. LED's are provided on the front panel for RS-232 transmit and receive monitoring. The Null Modem adapter is not used with an external modem via the RS-232 connector.

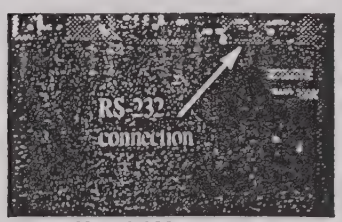


Figure 19: RS-232 connection

Using the Internal Modem

The PES/Model 7100 has an optional 9600 baud internal modem, which is mounted beneath the front panel sheet metal. A line-in RJ-11 jack is located beneath the front panel as shown in Figure 20. LED's are provided on the front panel for transmit/receive activity monitoring. To connect the Model 7100 to the switched telephone network, simply connect a standard RJ-11 phone line connector to the input RJ-11 jack.

Figure 21: RJ-11 connection

Connecting to a PC

4

Using the BMI Power Evaluation Software

To initialize the PES/Model 7100, either connect the RJ-11 phone jack to a dial-up phone line, or connect the RS-232 connector to a local PC or external modem with the Power Evaluation Software RS-232 cable. Then, using the BMI Power Evaluation Software, complete the instrument Set-up portion of the software. The BMI Power Evaluation Software User's Guide provides complete information about the instrument set-up procedure. Verify the LCD display readings of voltage and current for proper connections.

5 Need Help?

Things to Look For

When problems occur with the PES/ Model 7100, use the troubleshooting chart for possible causes and suggested solutions.

WARNING! *This servicing instructions in this manual are for use by qualified personnel only. To reduce risk of electric shock, do not perform any servicing unless you are qualified to do so. Incoming ground: The power plug is grounded. For continued protection against risk of electric shock and fire, do not defeat the grounded plug.*

Need Help?

5

The BMI Power Evaluation Software HELP Function

BMI's Power Evaluation Software includes an extensive on-line help facility. To initiate the help function, simply point the cursor to the large green "question mark" button found in the left hand tool bar, and click the left mouse button. The user then has a list of topics to choose from.

Power Evaluation Software HELP not only answers questions about how to use the software, but it also instructs users on the proper set-up and use of the instruments supported by Power Evaluation Software, including the Model 7100.

How to Contact BMI

Regardless of your location, BMI sales and product support are within easy reach through an established network of representatives and distributors worldwide. For technical support, specific product information, or the name of a BMI representative in your area, contact BMI by telephone at (800) 876-5355 in the U.S. or (408) 970-3700 outside the U.S., or by fax at (408) 970-3720.

6 Specifications

General Specifications

Voltage Inputs: Phase A, B, C, Neutral, Ground

Current Inputs: Phase A, B, C, Neutral

Power Types Supported:
Single phase, 3 phase 4 wire wye, 3 phase 3 wire delta, 3 phase 4 wire delta, dual single phase

User Interface

Graphic Display: Liquid-crystal display, 4 lines x 20 characters. Displays V_{rms}, A_{rms}, Time, Date, Power Type (Delta, Wye, etc.), Memory Usage, Site Name, Hardware Version, Firmware Version, and Battery Voltage

Software: BMI Power Evaluation Software, Microsoft® Windows™ based.

Ranges

Voltage:
80 to 600 V_{rms}, ($\pm$ 1000 V_{pk})

Current:
0 to 5 A_{rms} (8.333 A_{pk})
Model CT-5 Clamp-on Current Probe
or
0 to 150 A_{rms} (250 A_{pk})
Model CT-150 Clamp-on Current Probe
or
0 to 600 A_{rms} (1000 A_{pk})
Model CT-600 Clamp-on Current Probe
or
0 to 3000 A_{rms} (5000 A_{pk})
Model CT-3000 Clamp-on Current Probe

Specifications

6

Accuracy

Voltage:

±1.0% of reading ±1.0% of full scale through 2 kHz bandwidth

Current:

± 1.0% of reading ± 1.0% of full scale through 2 kHz bandwidth (for CT-600 only)

Data Storage

1.5 Mbyte RAM , memory storage priorities and allocations are defined by the user

Power Quality Measurements

RMS Disturbances:

Triggered on voltage sags and swells

1 cycle RMS sample interval

User-defined event duration

User-defined thresholds

Minimum storage capacity: 100 events

Harmonics:

Up to the 50th harmonic, voltage and current

THD (% of rms or % of fundamental) and spectral graph

Single-cycle snapshots

User-defined intervals

Build trends of total harmonic distortion or individual harmonics

Minimum storage capacity: 25 snapshots

RMS Summaries:

User-defined sample intervals and summary lengths

Minimum and maximum values for each interval

Averaged over one cycle

Minimum capacity: 31 days with a 15 minute sample interval

Waveshape Faults:

User-defined pre- and post-trigger cycles

Minimum storage capacity: 10 waveshape faults

6 Specifications

Impulses:
User-defined pre- and post-trigger cycles
Peak detection
Maximum impulse measurement: 1500 V
Minimum storage capacity: 10 graphic impulses

Power
Input Power: 80 to 250 Vac
Frequency Tolerance: 50 or 60 Hz, ± 0.1%
Surge Protection: 6 kV
Battery Backup: 14 days data protection

Environmental
Enclosure: NEMA 4X fiberglass, rainproof, dustproof, iceproof, corrosion resistant
Includes hinged door, lockable hasps, carrying handle

Temperature: 0° C to 45° C
Humidity: 0 to 95%, non-condensing

Physical
Size: 15.25"H x 14"W x 8"D
Weight: 18 lb.

Specifications are subject to change without notice.

7 Glossary

Amp, ampere: The quantitative unit measurement of electrical current.

ANSI: American National Standards Institute.

Bandwidth*: The range of frequencies within which performance, with respect to some characteristic, falls within specific limits.

Cold-load pickup: Monitoring, when power is reapplied, after loss of load diversity due to an extended outage. This event captures waveforms and rms levels of inrush current and voltage characteristics (of motor starts, transformers energizing, etc.) at the end of an extended outage.

Current: The flow of electricity in a circuit expressed in amperes. Current refers to the quantity or intensity of electrical flow.

Delta: A type of connection in a three-phase circuit, often the primary side of a transformer. A delta connection may or may not have a neutral connection.

Fundamental frequency: The primary frequency at which AC power is delivered to an end-user, usually 50 Hz or 60 Hz.

Harmonic: A frequency that is a multiple of the fundamental frequency.

Harmonic distortion: Excessive distortion in the voltage or current waveform that introduces harmonics frequencies.

Hz, Hertz: The frequency of alternating current. The term Hertz is synonymous with cycles per second.

Glossary

7

Hysteresis: The amount by which a threshold is altered in order to suppress disturbance data that would otherwise be triggered by small fluctuations in the measured signal. If hysteresis is used, the threshold is altered by the specific amount after an initial disturbance is triggered until the signal crosses the altered threshold. At this time, the threshold is restored to its original level. To turn off hysteresis, set the level to zero.

IEEE: Institute of Electrical and Electronics Engineers.

Impulse: Instantaneous voltage deviation which may not effect rms voltage because of its short time duration. Impulses can be caused by loads switching on line, loose wires, lightning, static, and power failures. Impulses can cause data disruption and equipment malfunction and damage.

kVA: Thousands of volts-amperes of apparent power.

kVAR: Thousands of volts-amperes of reactive power.

kW: Thousands of watts of actual power.

Neutral conductor: One of the conductors in a three-phase wye system. Sometimes called the return conductor, it carries the entire current of a single-phase circuit and the resultant current in a three-phase system.

Outage:** A complete loss of voltage for a time period.

Phase: The timing between two or more events tied to the same frequency.

7 Glossary

Power: The capacity for doing work. In the electrical environment, it is usually measured in watts.

Power factor: Watts divided by volt amperes, or the ratio of actual power to apparent power.

Power quality:** The concept of powering and grounding sensitive electronic equipment in a manner that is suitable to the operation of that equipment.

Sag: A short term rms voltage decrease that exceeds an established lower limit.

Steady-state wave: Periodic sample or snapshot of the voltage and/or current waveform.

Surge: See swell.

Swell: A short term voltage increase that exceeds an established upper limit.

THD, Total Harmonic Distortion: A percentage describing how much a measured waveform differs from an ideal sine wave.

Threshold: The point within which the measured parameter is said to be within tolerance.

True rms: A term used to describe the root-mean-square value of a waveform. "True" indicates that no assumptions that the waveform is a sine wave have been made, and harmonic distortion has been taken into account.

Glossary

7

Transient:** A subcycle disturbance in the AC waveform that is evidenced by a sharp, brief discontinuity of the waveform. May re of either polarity and may be additive to or subtractive from the nominal waveform.

Volt: The quantitative measurement of electrical force or potential also called electromotive force.

Voltage:** The force of electricity in a circuit as expressed in volts. It is the measure of work it takes to move a charge through a circuit.

Volt-second: Unit of measure that quantifies volts over time. It is used to measure the strength of an impulse.

Waveform: The graphic form of an electrical parameter.

Waveshape fault: A cycle to cycle change in the voltage waveform characteristic. A waveshape fault may not be large or fast enough to have impulse characteristics, and at the same time, may not add or subtract significantly from the voltage to create a sag or swell. Waveshape faults can be caused by loose wiring, switching between two power sources, etc. Waveshape faults can cause damage and disruption to all types of loads.

Wye: A three-phase connection with a single common neutral and three phase conductors.

*from IEEE Std 100-1984
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